NASA Electronic Parts and Packaging (NEPP) Program
2018 Electronics Technology Workshop

NEPP Program Task 18-294
Government Working Group Update

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Prepared by: MSFC ES43/Ron Hodge
MSFC ES43-ESSCA/Kathy Laird

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AGENDA

I. Acronyms

II. Purpose, Objective, & Scope

III. Accomplishments

IV. Current Topics

Acronyms

AMRDEC	**Aviation and Missile Research, Development, and Engineering Center**
Au/Sn	**Gold/Tin**
CT	**Computed Tomography**
DLA	**Defense Logistics Agency Land and Maritime**
DPA	**Destructive Physical Analysis**
EP	**Engineering Practice**
GSFC	**Goddard Space Flight Center**
GWG	**Government Working Group**
JEDEC	**Joint Electronic Device Council**
MIL-PRF	**Military Performance Specification**
MIL-STD	**Military Standard**
MSFC	**Marshall Space Flight Center**
NEPAG	**NASA Electronic Parts Assurance Group**
NEPP	**NASA Electronics Parts and Packaging**
NSWC	**Naval Surface Warfare Center**
PR	**Periodic Requalification**
R&R	**Read & Record**
QA	**Qualifying Activity**
QCI	**Quality Conformance Inspection**
QML	**Qualified Manufacturers Listing**
SEM	**Scanning Electron Microscopy**
SMC	**Space and Missile Center**
TRB	**Technical Review Board**
G11	**Component Parts Committee**
SMD	**Surface Mounted Device or Standard Microcircuit Drawing**
SSTC-G12	**Solid State Technical Committee**
TM	**Test Method**

Purpose, Objective, Scope, Meetings

GWG was established in January 2017

- **Purpose:** To discuss in detail government topics from NEPAG which require additional in-depth technical solutions
- **Objective:** To establish a one-government stance applicable to both terrestrial and space programs
- **Scope:** Attendees represent 6 government agencies and DLA
  - Air Force SMC/The Aerospace Corporation
  - Air Force – Wright-Patterson
  - Army AMRDEC
  - NASA Centers
  - Navy NSWC Crane Division
  - NRO/The Aerospace Corporation
- **Meetings:**
  - Held 30 meetings to date

1. Radiography Inspection Criteria

- **Developed a position which addressed a manufacturer's proposal to include the fillet as part of the intended seal width in MIL-STD-883 TM2012 Radiography and opposed the current requirement already in place in MIL-STD-750 TM2076 Radiography**
  - Two GWG's opposition presentations were given by Kathy Laird/NASA and Matt Dorcon/NSWC Crane at the JEDEC JC13 Task Group 15-02 X-Ray Seal Voids Meeting in January 2018.
    - The formation of the fillet is not a design feature of the seal process. Fillets form when solder flows out from under the lid during the seal process.
    - In most if not all cases, the fillet width by itself would meet the 25% required seal width.
    - Most 2D x-ray images do not reveal pullback or pin holes in the fillet next to the outer edge of the lid due to the thickness of the x-ray dense fillet.

Accomplishments

- **MIL-STD-883K Change 2 TM2012.10 Lid Seal Voids Requirements**
  - From paragraph 3.10.2.2 Unacceptable construction:
    - Any device wherein the integral lid seal is not continuous or is reduced from its designed sealing width by more than 75 percent.
    - Width reduction to less than 75% may be the result of either a single void or a combination of voids in the same width area (see figure 2012-7).
  - Fillets are not included in the designed (intended) sealing width.

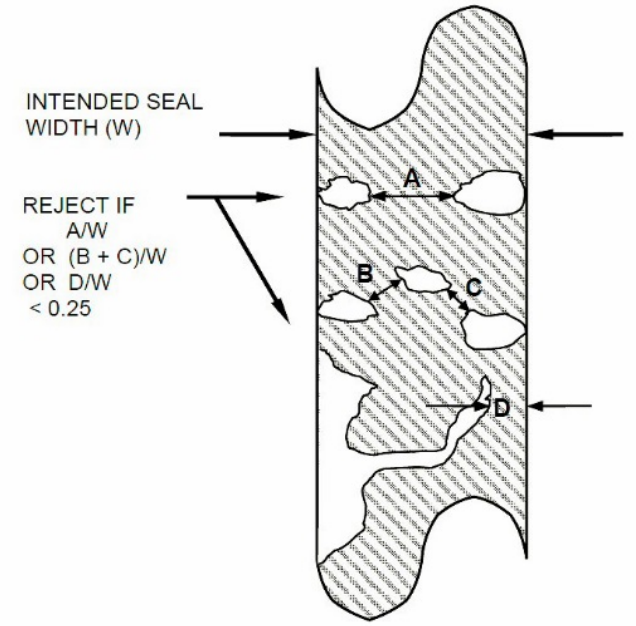


FIGURE 2012-7. Lid seal voids and rejection criterion.

Accomplishments

- **MIL-STD-750 TM2076 Lid Seal Voids Requirements**
  - 1.1.1 Designed sealing width. The metalized area where the package lid overlaps the package base (see figure 2076–7).
  - 1.1.2 Seal fillet. Exuded seal material, usually concave in shape, which extends from the edge of the package lid to the point of tangency of the package base (see figure 2076–7).
  - 3.8.2.3.2 Defective seal (see figure 2076–2). Any device wherein the lid seal (including the seal fillet when present) is not continuous or is reduced from its designed sealing width by more than 75 percent. The designed sealing width may be reduced by multiple voids (not to include pin hole voids).

    NOTE: Expulsion resulting from the final sealing operation is not considered extraneous material as long as it can be established that it is continuous, uniform, and attached to the parent material and does not exhibit a ball, splash, or tear-drop configuration.

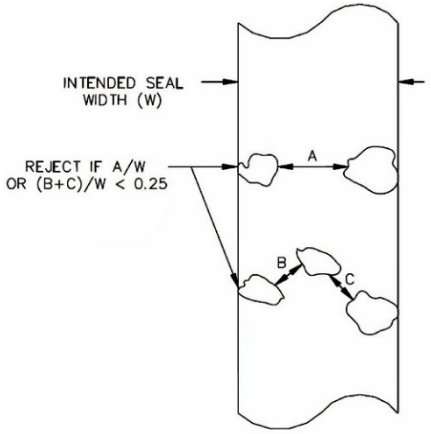


FIGURE 2076–2. Lid seal voids and rejection criterion (drawing).

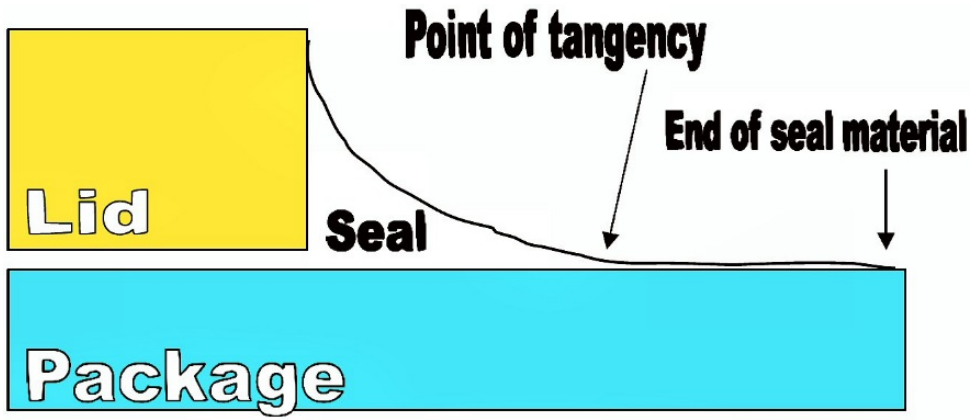


FIGURE 2076–7. Design sealing width and seal fillet graphic.

Accomplishments

- **Justification Not to Allow Inclusion of Fillet in Intended Lid Seal Width**
  - DLA Land and Maritime has no history of why fillet was included in the seal width for MIL-STD-750 product (requirement inserted in TM2076 in 1/3/2012)
    - M750 has significantly tighter leak rates than M883 and some believe the fillet inclusion was a compromise since tighter leak rates and this change were made in the same timeframe.
  - The fillet is not a design feature of the seal process.
    - Fillet width is not a controlled process.
      - Fillet forms when solder flows out from under the lid during the sealing process, and tapering of the fillet results in a non-uniform seal width (see figures on Slide 8).
      - Solder pullback severity can negate the seal effectiveness of the fillet.
      - Microcrack(s) not distinguished in x-rays may compromise seal integrity as they can propagate to a void area when part is placed on board or during box level and system level testing.

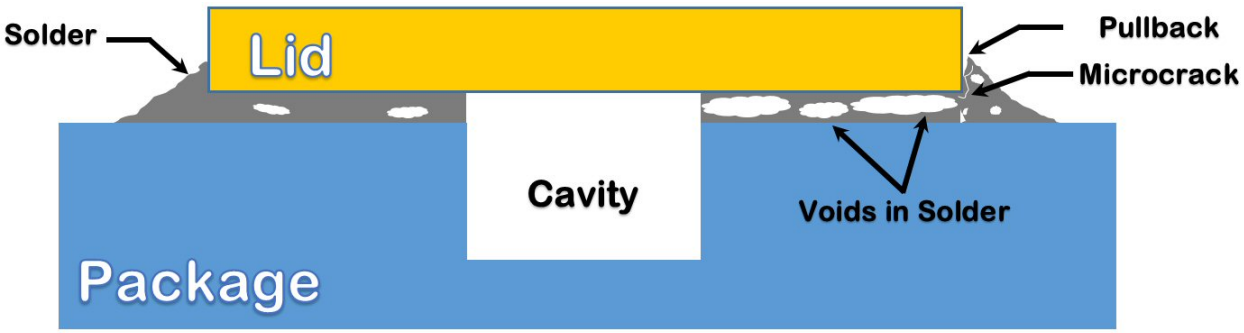
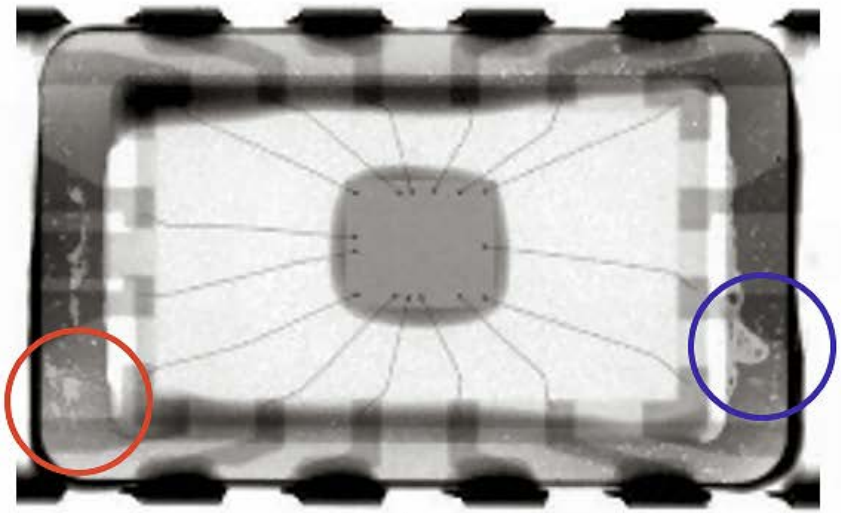


Figure illustrating voids, solder pullback, and microcrack in lid seal

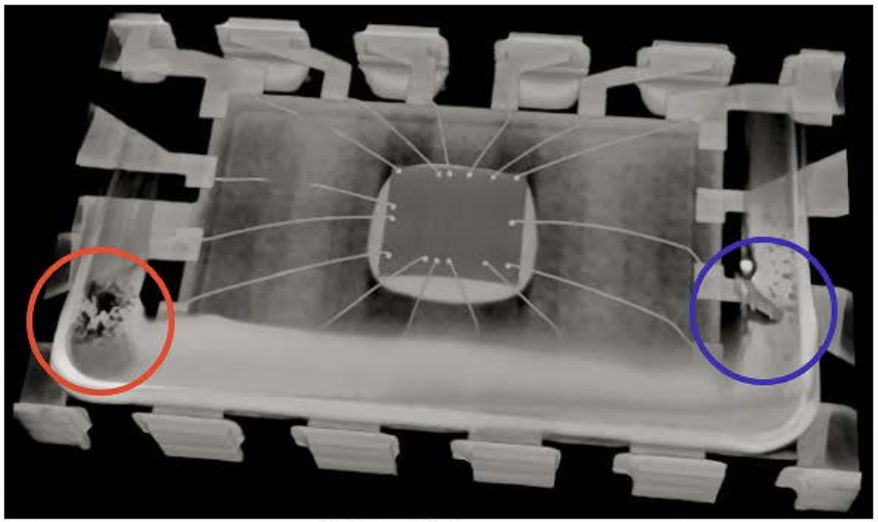
Accomplishments

- **Example 1: Excessive Voiding Underneath Lid**
  - Voids may reduce sealing width underneath the lid by more than 75% and also contact the fillet.
    - Microcrack(s), not distinguished in x-ray, may compromise seal integrity as they can propagate to a void area.
  - The current lid seal requirements would fail this device, yet pass if the fillet is included in the intended seal width.

Source: NASA MSFC Part and Images



2D Image



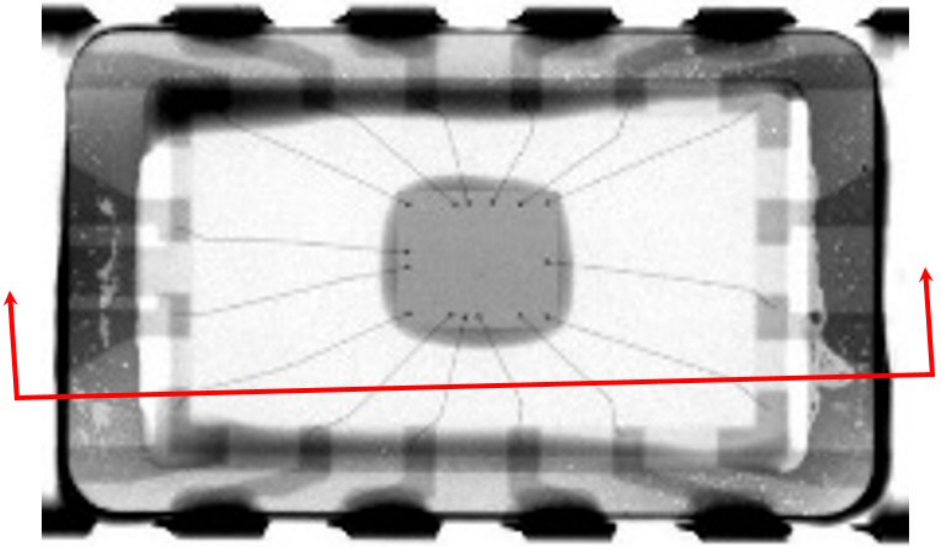
3D-CT Image

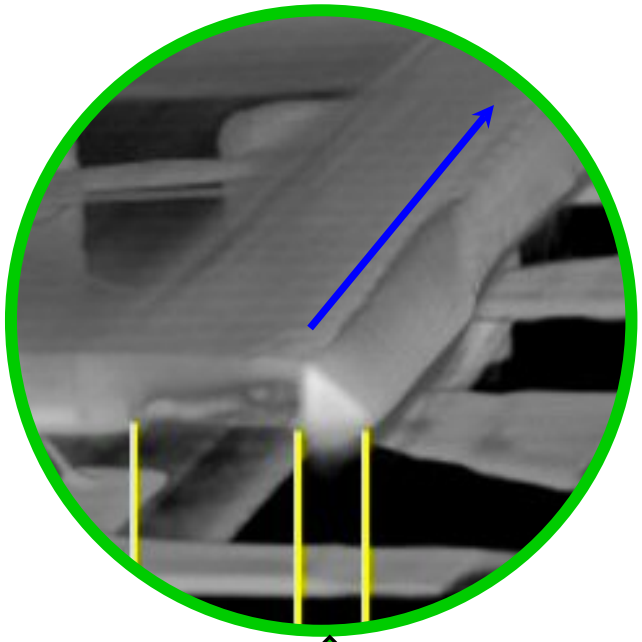
This part was a randomly selected sample and had this void issue. Because this part was randomly selected, it is highly probable that there are other parts with similar issues.

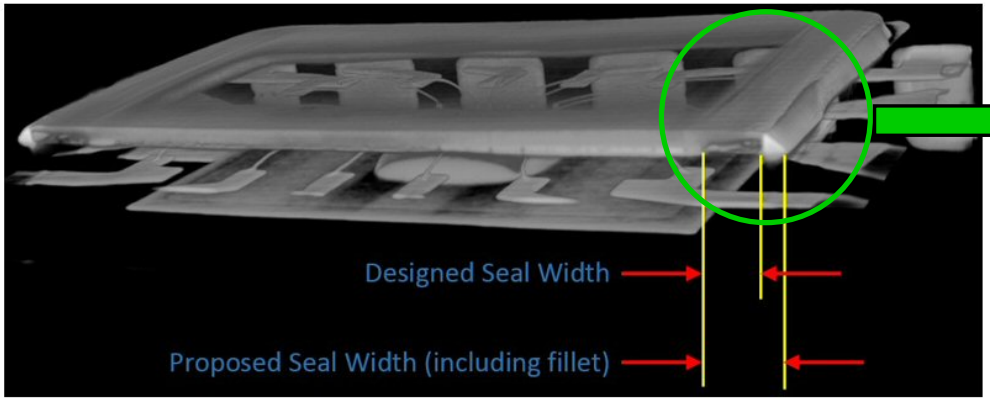
Accomplishments

- **Example 1: Excessive Voiding Underneath Lid (continued)**
  - The current lid seal requirements would fail this device, yet it would pass if the fillet is included in the intended seal width.

Source: NASA MSFC Part and Images





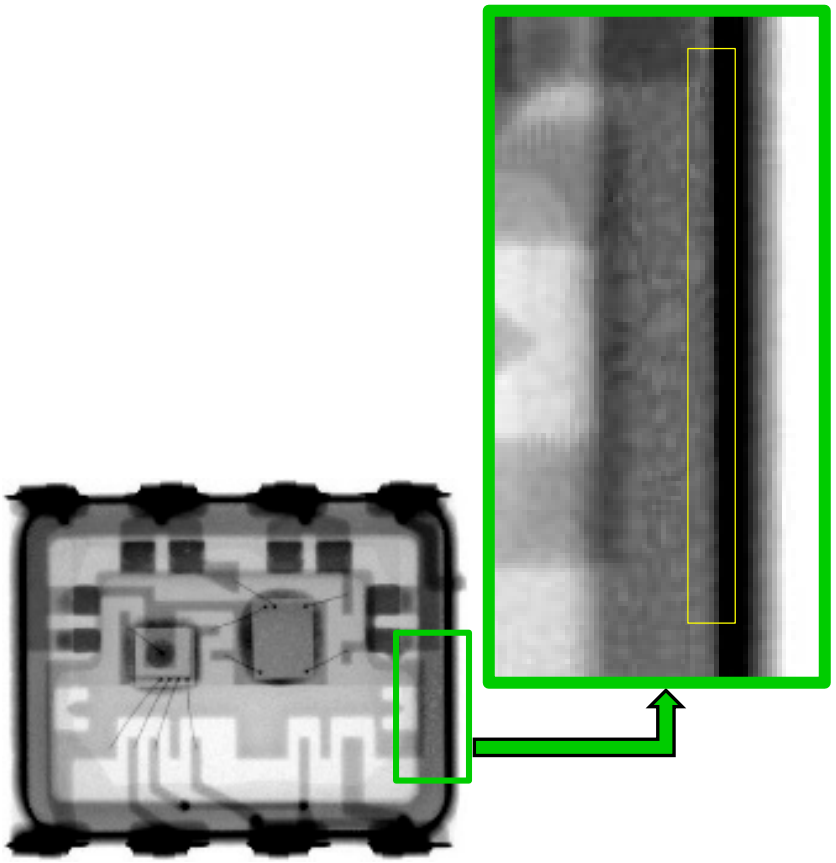


Darkened areas in the designed seal width are voids and the fillet width tapers (blue arrow).

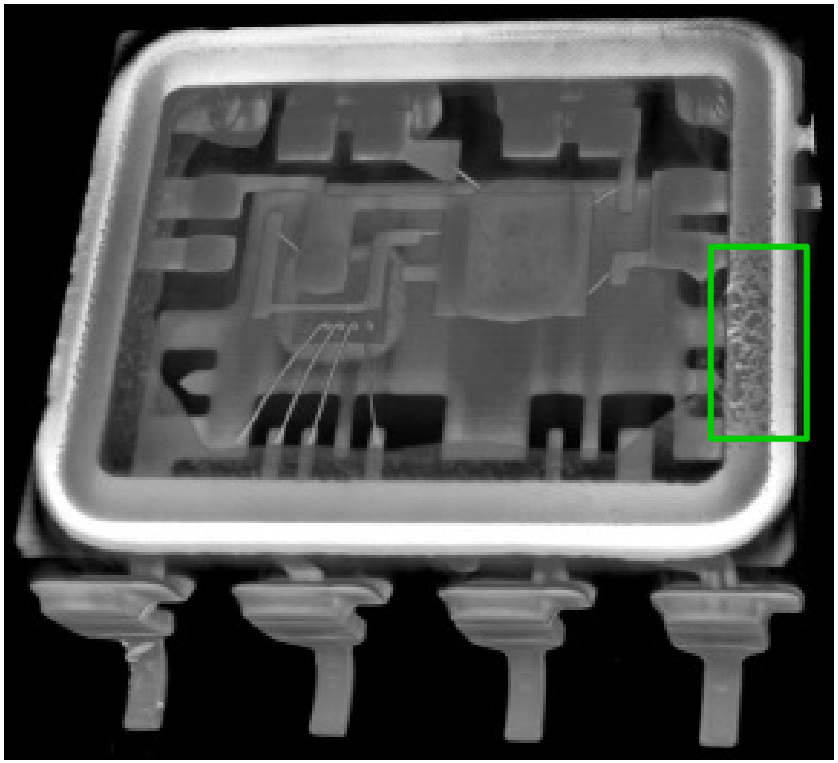
Accomplishments

- **Example 2: Excessive Voiding Underneath Lid**
  - Voids reduce sealing width underneath the lid by more than 75% and pinholes exist in fillet area next to the lid. Note that the pinholes are not clearly detected in the 2D x-ray image (yellow box) due to the thick, x-ray dense solder of the fillet.

Source: NASA GSFC Part and MSFC Images



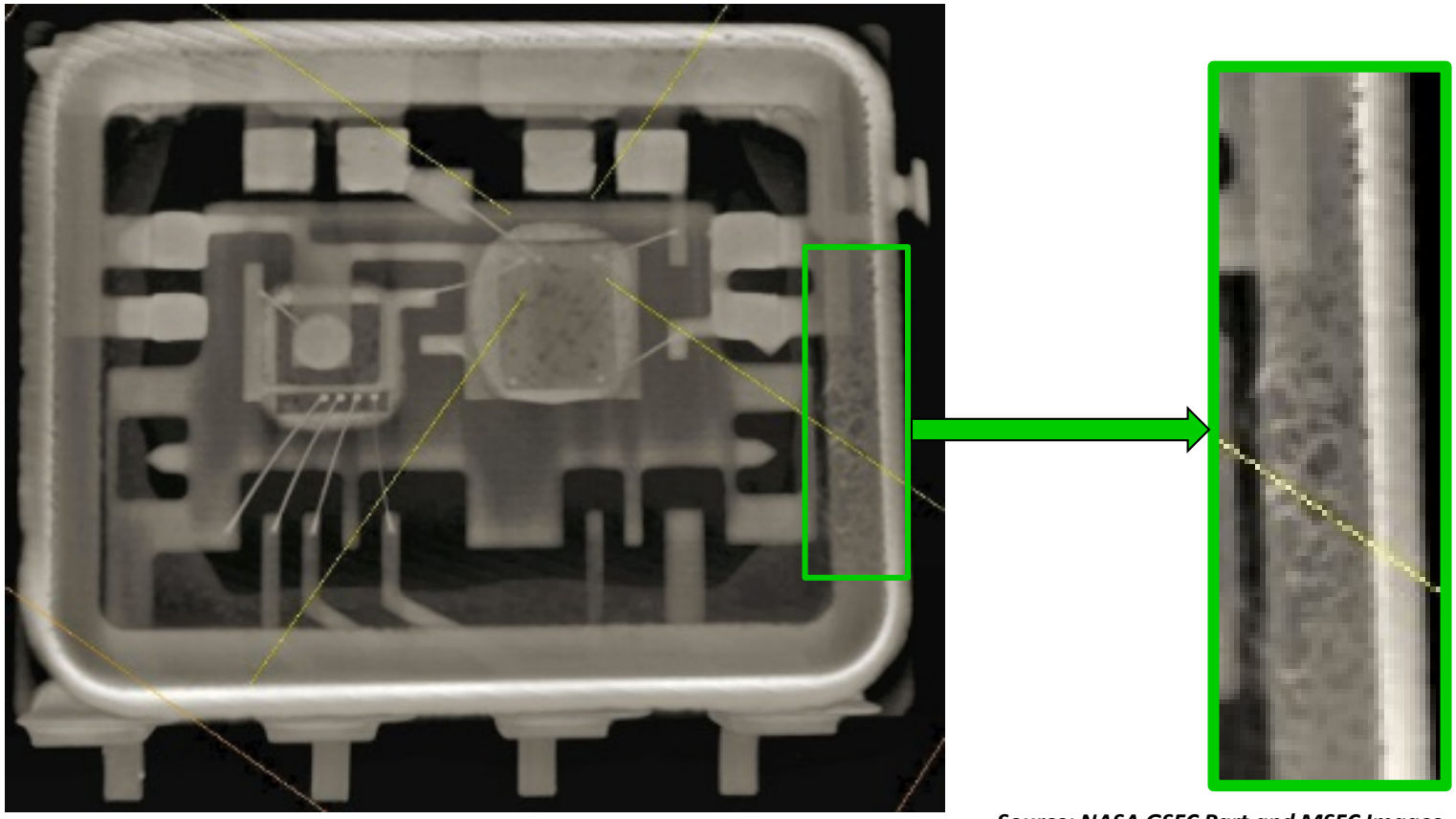
2D Image



3D-CT Image

Accomplishments

- **Example 2: Excessive Voiding Underneath Lid (continued)**
  - Another 3D-CT image of the device shown on Slide 9. This part would fail the current criteria, but would pass if the fillet was included in the design width. Note the pinholes in the fillet next to the edge of the lid, which provides a potential leak path.



Source: NASA GSFC Part and MSFC Images

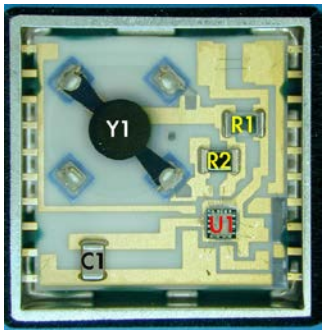
Accomplishments

• Conclusion

- After both GWG presentations, it was agreed by the JEDEC task group in January that the inclusion of the fillet as part of the intended seal width would not be added to MIL-STD-883 TM2012 due to the fact that is scientifically unsound to include a feature as part of the reject criteria when the analysis technique being used is unable to resolve the point of interest.
- The GWG also recommended the fillet allowance stated in MIL-STD-750 TM2076 be removed.
  - Even though TM1071 leak rate limits are tighter than those given in MIL-STD-883 TM1014 (with the exception of space level hybrid microcircuits), these tests are performed on pristine product, which does not take into consideration mechanical shock/vibration/thermal stress induced during handling, installation, board/box/system level testing, and end use.
  - GWG asked DLA and JEDEC for technical justification of why the fillet was added in the January 2012 release. They could not find any technical justification. This item will continue to be addressed at future JEDEC G12 meetings.

2. Military Document Draft Reviews

- **Technically reviewed 4 DLA draft documents, compiled 246 comments and submitted them to DLA for review.**
  - MIL-PRF-38535 Rev L Draft "Integrated Circuits (Microcircuits) Manufacturing, General Specification for"
    - 62 comments submitted
  - MIL-PRF-55310 Rev F Draft "Oscillator, Crystal Controlled, General Specification for"
    - 44 comments submitted
  - MIL-STD-1580 Rev C Draft "Destructive Physical Analysis for Electronic, Electromagnetic and Electromechanical Parts"
    - 137 comments submitted
  - MIL-STD-202 TM215 "Resistance to Solvents"
    - 3 comments submitted



Source: NASA GSFC J11186DPA

Work in Progress

- **JEDEC Task Group proposal to change MIL-STD-883 TM2012 X-ray lid seal failure criterion.**
  - Would remove “B + C” requirement and replace with seal length calculation along perpendicular line drawn from edge of package to cavity
  - Would allow fillets to be part of intended seal width
  - GWG does not support this change

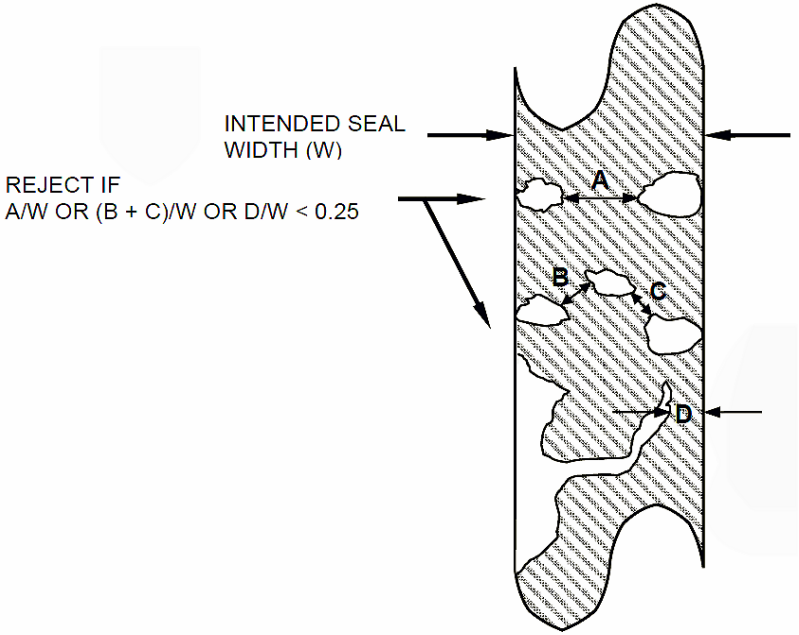


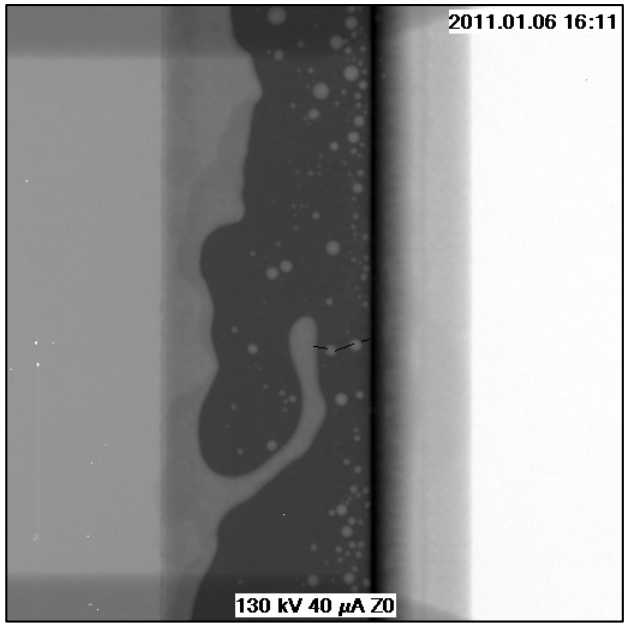
FIGURE 2012-5. Lid seal voids and rejection criterion.

From MIL-STD-883K w/Change 1 TM2012.9

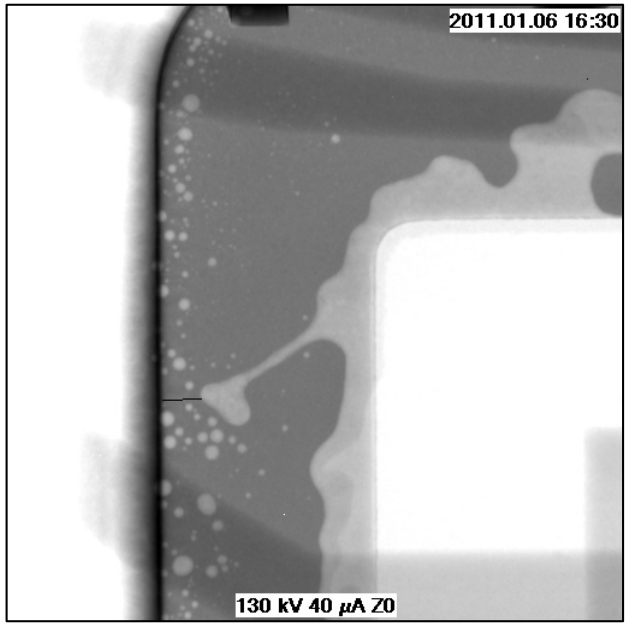
(continued on next page)

Work in Progress (cont.)

- **JEDEC Task Group proposal to change MIL-STD-883 TM2012 X-ray lid seal failure criterion (cont.)**
  - These microcircuits would pass the new criteria



A



B

X-ray Image of Voids

Source: A. NASA MSFC JN11-009 SN0079, B. NASA MSFC JN11-009 SN0167

Work in Progress (cont.)

- **Polymer Tantalum Capacitor MIL-Spec Development Working Group Activity Discussions**

Working Group Focus:

1. Develop MIL spec for polymer tantalum capacitors for a diverse range of applications (e.g., terrestrial airborne space, etc.). Two product levels shall be developed:
   - ❑ M Level for standard product
   - ❑ T Level for hi-rel (e.g., space)
2. Develop a series of slash sheets to cover specific product families/constructions. Possibilities include:
   - ❑ Standard single anode
   - ❑ Multi anode
   - ❑ Molded case vs. conformal coat

❖ *Hermetic leaded and hermetic surface mount capacitors most likely will not be included with this working group effort.*

Work in Progress (cont.)

- **Data Retention Requirements**
  - **Current data retention requirements are not the same for all commodities:**

MIL-PRF-38534:	3 years all Classes except Class K; Class K: 7 years
MIL-PRF-38535:	5 years (records pertaining to screening and quality conformance)
MIL-PRF-19500:	10 years
MIL-STD-790:	The records pertaining to production processes, incoming, and in-process inspections should be retained for a minimum of 3 years (7 years for space level) and those pertaining to performance verification retained for a minimum of 5 years (7 years for space level) after performance of the inspections. Records pertaining to alternate methods (with qualifying activity approval), conformance testing shall be retained for 5 years (7 years for space level) after the process or materials affected have been removed from the qualified flow.

- **GWG requested DLA to perform an EP Study. We provided proposed wording and survey questions for manufacturers input.**

Work in Progress (cont.)

- **Data Retention Requirements (cont.)**
  - **The proposed requirement wording consisted of the following:**

Record retention. The manufacturer of QML devices (all class levels) shall retain all design, manufacturing, testing and quality records for each lot for a period of 15 years after delivery of product. The records shall include as a minimum:

a. Design
b. Manufacturing
c. Travelers
d. Inspection
e. Test results
f. Screening results
g. Qualification plans and results
h. Quality conformance test results
i. Rework
j. Failure analysis and corrective actions
k. TRB decisions
l. Training
m. Customer returns

The records shall be retained in the form in which they were originally defined but electronic media is preferred and a copy shall be provided to the qualifying and/or procuring activity as requested.

Work in Progress (cont.)

- **Data Retention Requirements (cont.)**
  - **The EP Study survey questions posed were as follows:**

1. What is the standard amount of time manufacturers retain data for military products? For commercial products?
2. Is a proposed 15 year retention time acceptable?
3. What concerns do manufacturers have with retaining records electronically?
4. Can all lot data be retained, including travelers, incoming inspection, R&R, screening, QCI, etc. If the answer is no, what data can be retained?
5. What financial hardship, if any, would this endeavor impose?
6. For users of military devices, are there any additional types of data that you would like to see retained?

Work in Progress (cont.)

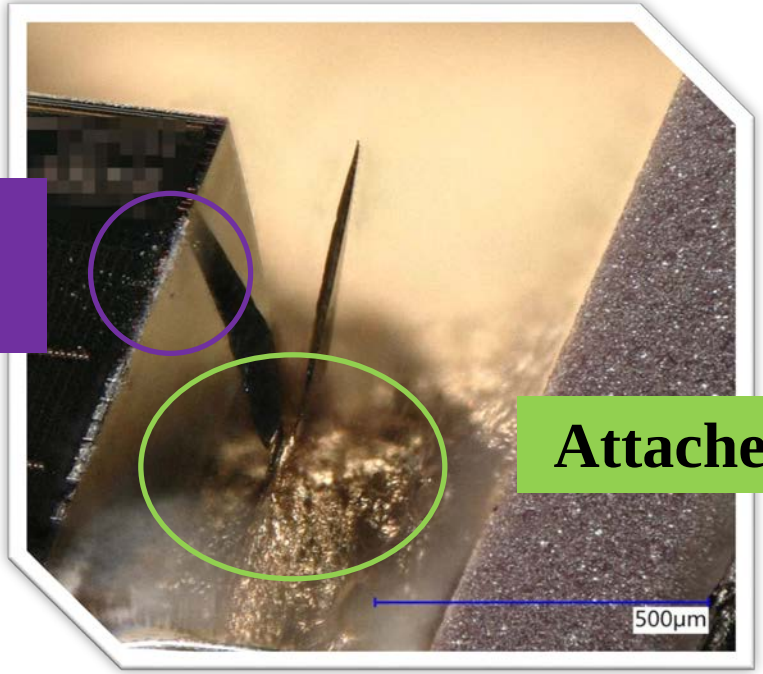
- **Data Retention Requirements (cont.)**
  - The EP Study will remain open to conduct an internal DLA review to consider additional coordination with stock classes using MIL-STD-790 or other data retention requirements.
  - Results will be used to help determine appropriate proposals to standardize data retention requirements across related commodities.

DLA Contact Info:
Jason Hochstetler (DLA-VAC)
Jason.Hochstetler@dla.mil
614-692-7106
https://landandmaritimeapps.dla.mil/Downloads/MilSpec/Docs/MiscEPStudies/EPS1162DataRetAllFSCs.pdf

Source: DLA-VAC

Work in Progress (cont.)

- **Die Chip Out Issue**
  - NSWC Crane had an internal visual DPA inspection issue where 1 MIL-PRF-38535 Class Q device failed during Lot Acceptance Testing.
  - During inspection a die chip out was found that poses a latent FOD risk.



Source: NSWC Crane

Work in Progress (cont.)

- **Die Chip Out Issue (cont.): DPA Internal Visual Flow**

MIL-STD-1580 (DPA)

Requirement 16 – Microcircuits Detail Requirements

16.1.1 – DPA IAW MIL-STD-883 TM5009

MIL-STD-883 TM 5009.1 (DPA)

Section 3.4.5 – Internal Visual

TM 2010.14

Internal Visual

- OR -

TM 5004.13

(Ap[illegible] A)

[illegible]b

Screening

TM 2013.1

Internal Visual for DPA

TM 2014

Inter[illegible]al and Me[illegible]ical

Source: NSWC Crane

Work in Progress (cont.)

- **Die Chip Out Issue (cont.)**
  - Per TM2013 device fails DPA inspection criteria for cracked / broken die but per TM2010 it passes.
  - TM2013 section 3.1 criteria references TM2010 so the inspection criteria should be similar. However, TM2010 chip-out criteria is only for flip chip.
  - Why chip-out criteria is only for flip chip is yet unclear. (TM2010). There is a need for clarity of this anomaly in TM 2010 in the next revision of MIL-STD-883.

Questions?

Contact Information:

- Kathy.R.Laird@nasa.gov
- Jeffrey.H.Sokol@aero.org